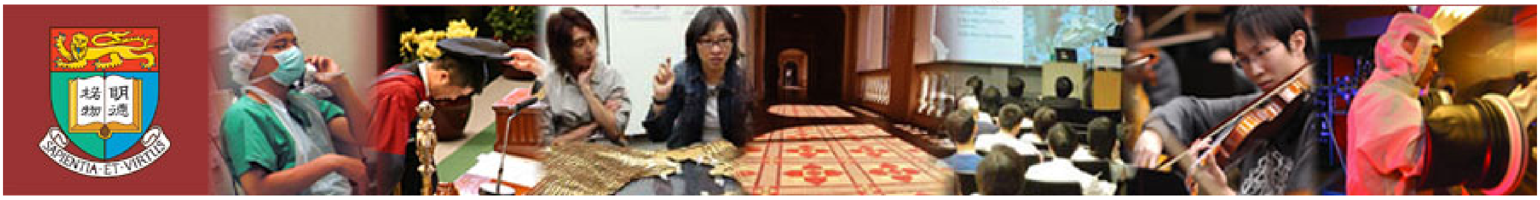

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Distributive Radiation Characterization Based on the PEEC Method

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The intentional and unintentional radiations are of great importance to wireless power transfer at the low frequency regime and antenna signal transportation at the higher frequency regime. Due to the rising speed of digital systems and thereby broad bandwidth of signal channels at all levels of electronic devices, it becomes more essential than ever to quantitively analyze, model, and illustrate how the energy is leaked out and which part is a greater contributor to the wanted or unwanted radiation.

However, conventional computational methods seem to be not sufficient to answer these questions. They mostly focused on characterizing port based properties such as matching condition and insertion losses, or gave general efficiency description and radiation patterns. But it is not clear how the energy is radiated and coupled from different parts of the radiator. For computational electromagnetics algorithms, they blended all physical phenomena together and made the radiation property extraction and analysis not straightforward.

In this work, we extend the partial element equivalent circuit (PEEC) method to distributive radiation analysis so that the radiation and coupling contributions from each segment of the whole radiator can be singled out. Instead of focusing on the conventional circuit modeling method of PEEC, we focus on distributive radiated power and transferred power calculation. To fully stick to the first principle without sacrificing reliability, dynamic Green's function is used throughout the proposed method, not only for the coupling term, but also for the self term.

A great significance of this work is that it can help to provide eligible lossy model of antenna structures and meta surfaces more accurately, which avoids approximations and curve fitting methods frequently used in RF and microwave engineering designs to make the circuit model more physical. For example, we can benchmark the idea through the coupling and radiation mechanism of arbitrarily electrical radiators and magnetic radiators. The radiated power and coupled power between coupled structure will be systematically calculated and analyzed using the proposed method. It gives much more insights than the conventional radiation impedance concept.

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